DOCUMENT RESUME

ED 368 068 EA 025 702

TITLE Post-Earthquake Damage Evaluation and Reporting Procedures: A Guidebook for California Schools.

INSTITUTION California Office of the State Architect, Sacramento.; California State Office of Emergency Services, Sacramento.

SPONS AGENCY Federal Emergency Management Agency, Washington, D.C.

PUB DATE Mar 93

NOTE 19p.

PUB TYPE Guides - Non-Classroom Use (055) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Earthquakes; Elementary Secondary Education; *Emergency Programs; Public Schools; *School Buildings; *School Safety; State Agencies; State Programs

IDENTIFIERS *California

ABSTRACT

The California Office of the State Architect, Structural Safety Division (OSA/SSS) is responsible for evaluating public school structures after an earthquake. However, final authority on whether a building should be reoccupied after damage lies with the school district. This guidebook is designed to help school officials assess earthquake damage before a qualified engineer arrives at the site and report building conditions to OAS/SSS to assist in establishing a priority list for site visits by structural engineers. School personnel and inspectors must be careful when entering a damaged building after an earthquake and should only do so in teams of two. The first step to inspecting a building after an earthquake is surveying the building from the outside. Second, the surroundings of the school or facility should be checked for geotechnical hazards such as cracks or bulges in the ground or hillsides. The third step is inspecting the structural system of a building from the inside if possible. Nonstructural as well as structural hazards should be noted. The need for locking or barricading the building should also be determined. Finally, notification of authorities should be carried out. (JPT)

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California Office of Emergency Services

Earthquake Program

POST-EARTHQUAKE DAMAGE EVALUATION AND REPORTING PROCEDURES

A GUIDEBOOK FOR CALIFORNIA SCHOOLS

EA 025702

Office of the State Architect

HARRY C. HALLENBECK, FAIA • STATE ARCHITECT

Structural Safety Section

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POST-EARTHQUAKE DAMAGE EVALUATION AND REPORTING PROCEDURES

A GUIDEBOOK FOR CALIFORNIA SCHOOLS

March 1993

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The information in this guidebook is consistent with procedures established in ATC 20: ***Procedures for Postearthquake Safety Evaluation of Buildings***, developed by the Applied Technology Council. The ATC 20 document may be purchased from the Applied Technology Council, 555 Twin Dolphin Drive, Suite 550, Redwood City, CA 94065-2102, (415) 595-1542.

Cover photo: A classroom in the Loma Prieta Elementary School following the October, 1989, Loma Prieta earthquake.

This work was supported in part through a cooperative agreement between the Federal Emergency Management Agency and the California Office of Emergency Services. The recommendations and suggestions included in this document are intended to improve earthquake preparedness, response and recovery. The contents do not necessarily reflect the views and policies of the Federal Emergency Management Agency and do not guarantee the safety of any individual, structure, or facility in an earthquake. Neither the United States nor the State of California assumes liability for any injury, death or property damage which occurs in connection with an earthquake or with the use of this document.

INTRODUCTION

The Office of the State Architect, Structural Safety Section (OSA/SSS), is responsible for the post-earthquake evaluation of public school buildings (kindergarten through community colleges) in California. OSA/SSS acts in an advisory capacity to a school district. However, the final authority as to whether a school building is to be reoccupied lies with each school district. Immediately following a damaging earthquake, power, communications and transportation routes may be disrupted and may keep OSA/SSS engineers from making timely post-earthquake safety evaluations. The procedures suggested in this guidebook are intended to assist on-site school personnel in:

- discovering possible earthquake damage hazards before a qualified engineer arrives at the school site,

- reporting building conditions to OSA/SSS to assist in establishing a priority list for site visits by structural engineers.

It is the policy of OSA/SSS to have post-earthquake safety evaluations performed by California registered structural engineers at all school sites that report damage. School districts are encouraged to make prior arrangements with a local, California-registered, structural engineer holding a valid OES Disaster Service Worker card to perform a post-earthquake evaluation of their facilities using the procedures established in ATC-20*: **Procedures for Postearthquake Safety Evaluation of Buildings***.

Regardless of who performs the safety evaluation, a California school district is still expected to report to OSA/SSS, in accordance with the procedures in this guidebook.

This inspection procedure is designed for use by individuals with some building construction or inspection experience; however, the procedure can be used by anyone during an emergency. School districts should assign personnel at each campus, faculty as well as maintenance staff, to perform these inspections. Training of prospective inspectors is strongly encouraged.

It has proven very beneficial to keep a set of structural drawings for permanent school buildings on-site, preferably in an easily accessible location. These plans are then available to the structural engineers for post-earthquake use and can assist on-site personnel in identifying the structural systems.

PERSONAL JUDGEMENT WILL BE NECESSARY

In areas of severe earthquake shaking, collapsed buildings or falling debris pose substantial danger to students, faculty and staff. Strong aftershocks can also dislodge building material. The first priority is protection of the building occupants; therefore, if damage is suspected, appropriate evacuation procedures of occupants to a safe refuge area should be completed before preliminary damage inspection is undertaken. When evacuation is necessary, the inspector should perform a rapid inspection of the route to make sure it is accessible and unobstructed. If an established evacuation route is blocked, or otherwise inaccessible, an alternate route will need to be found.

If a building is clearly hazardous, no one should enter it, other than for search and rescue. Clearly, **no inspector should enter a building that is near collapse, or where there has been a hazardous material release** (e.g., damaged asbestos fireproofing, toxic chemical spill). Inspectors should not take any other undue risks, whatever they may be.

An inspection of a school campus should be done if the level of ground motion was large enough to cause books to fall off shelves. Many factors in addition to the magnitude of an earthquake may contribute to the shaking intensity a building experiences. Large earthquakes at great distances and nearby small earthquakes can cause ground motions strong enough to damage buildings.

Use of judgement is essential in the evaluation of damaged buildings. Not every dangerous situation is covered by the guidelines and procedures given here. In situations for which no guidance has been provided, or when guidance furnished is not appropriate, the inspecting teams must rely on their collective experience and judgment.

Inspectors must be conscious of their own safety and that of their team members at all times. Inspectors should work in teams of at least two so help is readily available in case a student is discovered or one member of the team is trapped or injured. If the partner can not provide immediate assistance, he or she can go for help.

When conducting preliminary damage assessments, inspectors should be alert to the potential of falling objects, both inside and outside buildings. Outside a building, parapets, glass, building ornamentation, and other types of attachments may fall. Inside a building, ceilings, piping and ductwork, light fixtures, and heavy furniture, such as file cabinets and bookcases, may move or fall. These elements may fall of their own accord at any time during the earthquake, during an aftershock, or after the shaking stops. Inspectors should be prepared to duck, cover and hold in the event of aftershocks.

A fundamental assumption in the evaluation process is that in order to declare a structure safe, it must be capable of withstanding at least a repetition of the earthquake that caused the initial damage without collapse and without additional risk from falling (or other) hazards. It should be emphasized, however, that **THIS IS A MINIMUM REQUIREMENT** and a difficult engineering assessment to make. This non-technical assessment guideline provides for a cursory estimation of the safety of damaged buildings. If the inspection team is unsure as to the significance of the damage observed, errors on the side of student safety are strongly advised.

INSPECTION PROCEDURE

If an earthquake may have caused damage to a facility, building occupants should be evacuated through pre-established evacuation routes, if they are accessible and clear, to a safe refuge before a preliminary damage assessment is conducted.

STEP 1: Survey the Building from the Outside

A. Try to determine the structural system (*i.e.*, the skeleton) of the building.

For example: Structural systems are wood studs with plywood sheathing, brick masonry walls, concrete block masonry walls, concrete walls, concrete posts and beams, steel posts and beams, and steel posts and beams with diagonal steel braces.

B. Examine all accessible sides of the structure for damage. Pay particular attention to buildings with the irregular shapes noted in Figures 1 and 2 on the following pages. Damage to the structural system will typically show through nonstructural finishes. For example, cracks in stucco or plaster finishes are assumed to be equal in size to the cracks in the structural system hidden behind the finish. Typical visible damages are as follows:

1) Wood studs with plywood sheathing - new gaps between plywood sheets 1/8" or larger, nail heads pulled out, or cracks l/8" or larger in stucco over plywood. Indicators of possible severe structural damage.

2) Brick masonry walls, concrete masonry walls or concrete walls - cracks l/8" or larger indicate possible severe structural damage.

3) Concrete columns and beams - hairline cracks are generally not considered dangerous unless widespread. Exposed steel reinforcing, spalling of the concrete, or severe cracking indicate possible severe structural damage.

4) Steel posts, beams, diagonal braces and/or trusses - any buckling or bending (usually indicated by cracked or chipped paint) or any bolt failures or cracked welds indicate possible severe structural damage.

C. Look for indicators of excessive horizontal movement in exterior walls which may result in a building being out-of-plumb (*i.e.,* the top of the wall not in line with the bottom of the wall). Two typical indicators are broken glass in windows and jammed doors, but a building can move without breaking windows or jamming doors and still be out-of-plumb. Standing 20 to 30 feet from the corner of the building, look along all four edges of the building, checking for locations where the building is leaning. An offset from the top to the bottom of a wall, beyond what may have existed prior to the earthquake, of 1" or more may indicate severe structural damage.

D. Examine exterior nonstructural elements, such as brick veneer, exterior cladding, overhangs, canopies, parapets, signs, and ornamentation, for damage before evacuating or re-entering the building. Exterior cladding could be metal panels or precast concrete panels.

E. Look for new fractures in the foundation or exposed lower walls of the building.

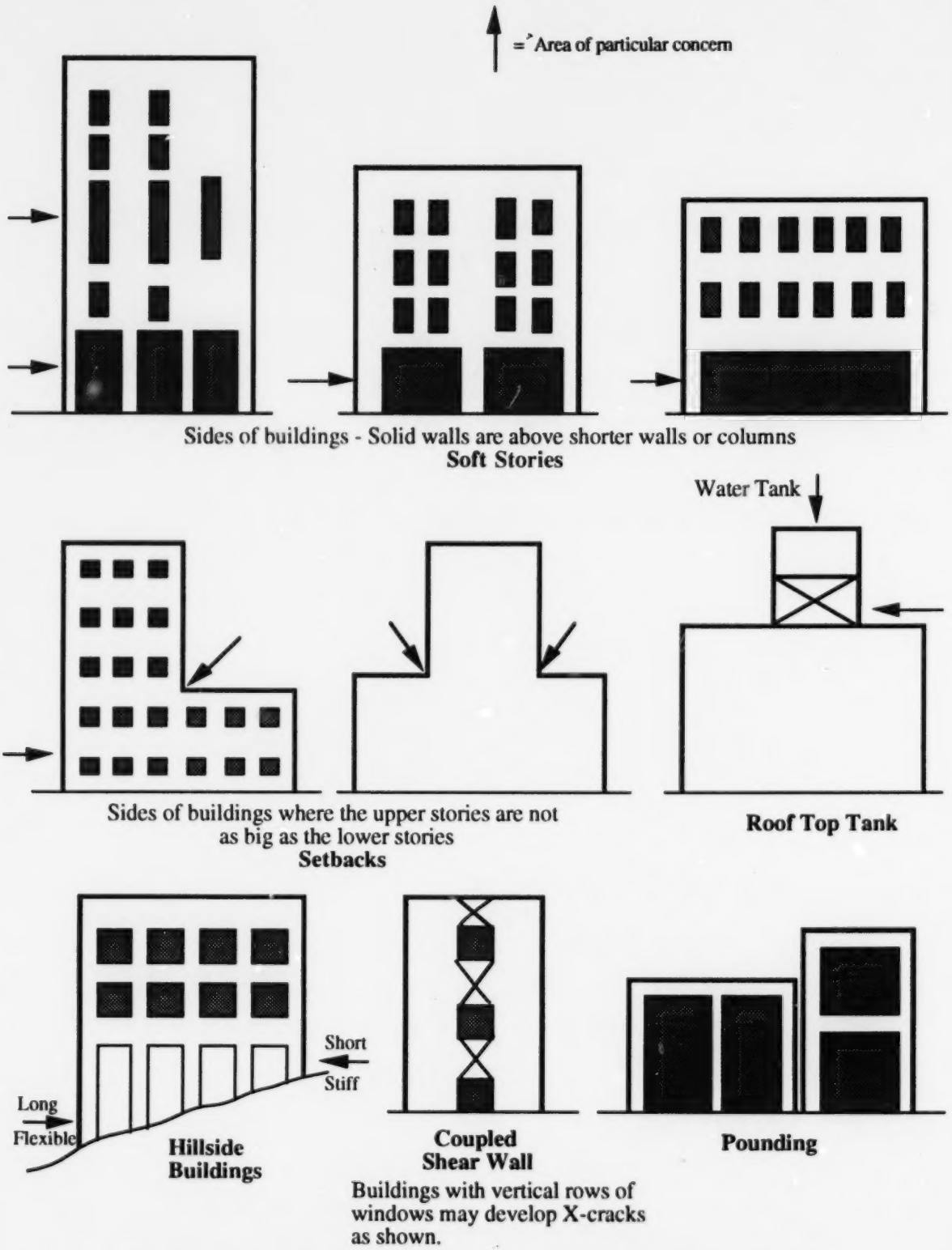
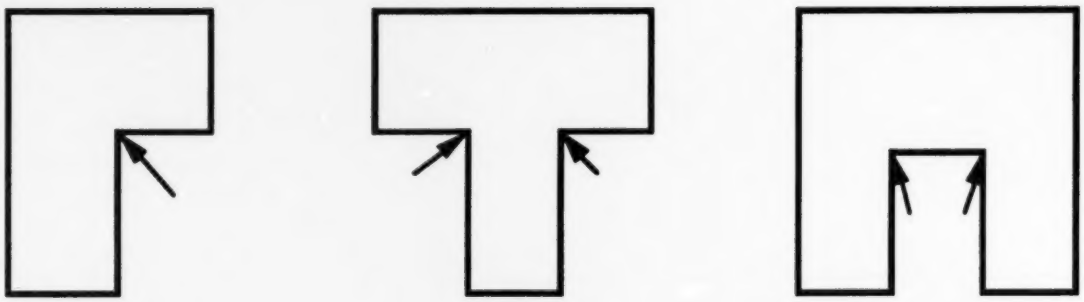

= Area of particular concern
Sides of buildings - Solid walls are above shorter walls or columns
Soft Stories
Water Tank
Sides of buildings where the upper stories are not as big as the lower stories
Setbacks
Roof Top Tank
Short
Stiff
Long
Flexible
Hillside Buildings
Coupled Shear Wall
Pounding
Buildings with vertical rows of windows may develop X-cracks as shown.

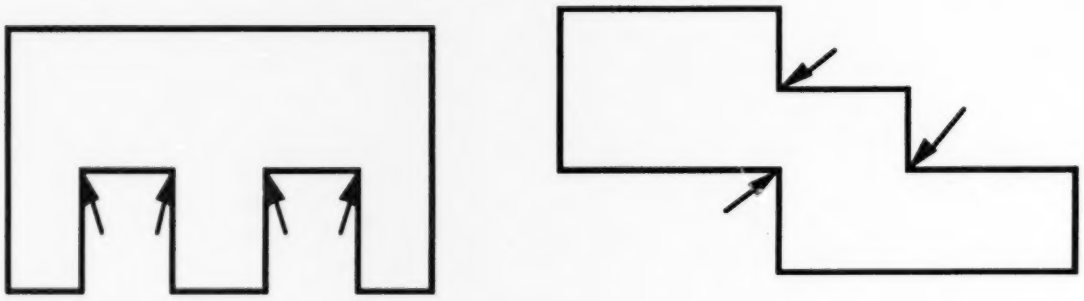
Figure 1 Structural systems with irregular shapes when viewed from any side



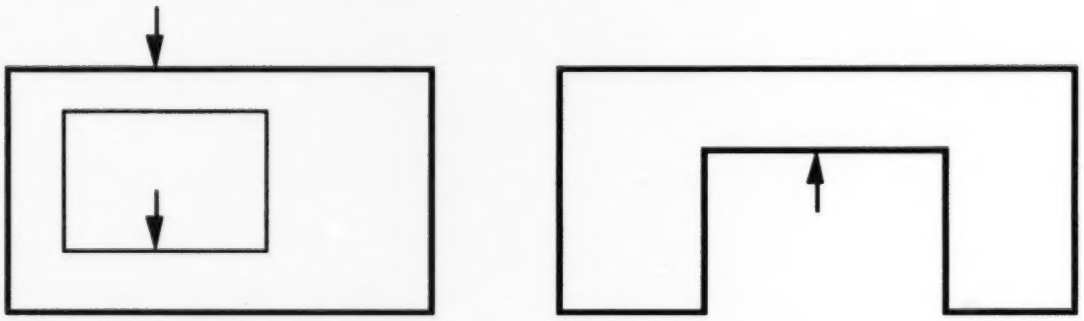
L - Shaped

T - Shaped

U - Shaped



Other Complex Shapes



Large Opening in Diaphragm

Weak Diaphragm Link

= Area of particular concern

Figure 2 Buildings with irregular shapes when viewed from above

STEP 2: Examine the Surrounding Site for Geotechnical Hazards

Geotechnical hazards are conditions which affect the supporting soils around and under buildings. Geotechnical hazards may be off-campus. The school district should be contacted for any geotechnical hazard information related to the campus. If geotechnical hazards are known to exist, this information should be added to the school's emergency preparedness plan so inspectors will know to look for these conditions,

A. Look for cracks, bulged ground and vertical ground movements in the area (see Figure 3).

B. Examine hillside areas, above and below the site, for landslide displacement or debris encroaching onto the site (see Figure 3).

C. Remember that geotechnical hazards can extend over an area of several buildings or sites.

D. When geotechnical hazards are suspected, a detailed evaluation must be made by a geotechnical engineer or geologist before a decision can be made about reoccupying the building.

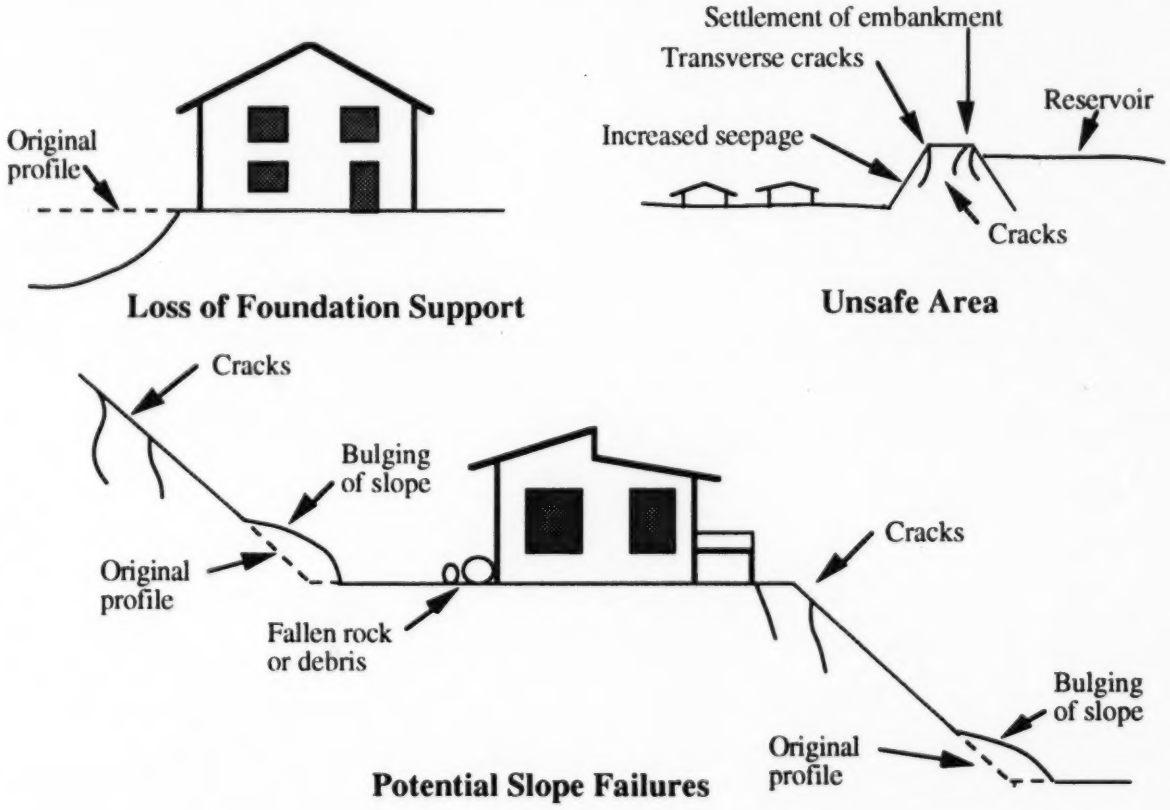


Figure 3 Inspection points for some geotechnical hazards

STEP 3: Inspect the Structural System from Inside the Building

Has the load-carrying capacity of the structure decreased significantly?

A. Before entering the building, look to see if anything could fall on you or if the building is in an imminent state of collapse. **DO NOT ENTER OBVIOUSLY UNSAFE BUILDINGS.**

B. Ceiling panels may be removed to view the structural system, but any destructive exploration, such as cutting a hole in a wall, must be done only when authorized by the school district.

C. Look in stairwells, basements, mechanical rooms, and other exposed areas to view the structural system (see Step 1B for additional guidance).

D. Examine the vertical load-carrying system. Look for situations in which (1) a post may show signs of damage; (2) the floor or roof beams have begun to pull away from their supports; or (3) the slab or beam system has been damaged.

E. Examine the lateral load-carrying system. Any new offset such that the walls at any level are out-of-plumb with the wall below means some structural damage has been sustained. Look for situations in which a diagonal brace has buckled, bowed or cracked, or where walls have bowed or cracked.

F. Inspect the basement for fractures and uneven settlement. Also inspect basement floors and exterior walls for cracks and bulges.

G. Examine every floor, including basement, roof, and penthouse.

H. Gypsum wallboard (sheetrock) and painted plywood walls show signs of distress if the nailheads show, generally at the edge of the wall. If just a few nailheads show, usually the strength of the wall has not decreased. However, if many nail heads show or the shank of the nail is visible, the strength of the wall has decreased significantly.

STEP 4: Inspect for Nonstructural Hazards

A. Look inside the building for damage to nonstructural elements such as ceilings, partitions, light fixtures, roof top tanks and other interior elements. Damage to these nonstructural elements could either indicate structural damage, or pose a threat to occupants.

STEP 5: Inspect for Other Hazards

A. If damage to elevators is suspected, or if the elevators will not operate (seismic switch has been tripped), they should not be restarted without first being inspected by a qualified elevator inspector.

B. Look for spills or leaks in areas of stored chemicals or other hazardous materials. **DO NOT** attempt to handle these materials yourself. Restrict building or area use accordingly.

C. If there is damage to fire protection and detection equipment, it may be necessary to restrict building use. Notify the local fire department. Look for damage to sprinkler systems, piping, and smoke detection components of signal systems.

D. Inspect the stairs to verify they are stable, and inspect exits for jammed doors and obstructions.

STEP 6: Determine the Need for Locking or Barricading Buildings and the Priorities for Notification

A. If conditions 1 through 4 of the preliminary evaluation criteria (see Table 1) have been met, make sure everyone is out of the building, lock the building and prevent access.

B. If conditions 5 through 8 of the preliminary evaluation criteria exist (see Table 1), then the hazard area must be barricaded or locked to prevent access. If the potential falling hazard or hazardous material is outside the building, some form of barricading should be established to make students, faculty and staff aware of the hazards and keep them well away from the condition. If the conditions exist inside the building, locking the building to prevent access should be sufficient.

C. Explain the locked and/or barricaded areas to faculty, students, staff and parents. Post an explanation of the reasons for locking the area near the entrance and include a contact name and phone number for parents, teachers, and post-earthquake inspection engineers.

D. Report the school site condition to the school district using the reporting codes established in Table 2.

E. If it becomes necessary to reoccupy some of the school buildings before a structural engineer has evaluated the safety of the building, do not occupy obviously unsafe structures. Reoccupancy of gymnasiums and multipurpose rooms is not encouraged as these structures are more difficult to inspect and generally are subject to higher stresses than individual classroom buildings. More modern buildings are generally more earthquake-resistant than older buildings.

CAUTION: Aftershocks can cause additional damage. After each significant aftershock, all occupied buildings should be re-inspected.

TABLE 1 PRELIMINARY EVALUATION CRITERIA

This table will be used to determine the condition of a building and to give guidance on appropriate action.

CONDITION	ACTION
1. Building has collapsed, partially collapsed or moved off its foundation.	**DO NOT OCCUPY PREVENT ACCESS**
2. Building or any story is leaning significantly.	**DO NOT OCCUPY PREVENT ACCESS**
3. Obvious severe damage to primary structural members, severe leaning of walls or other signs of severe distress present.	**DO NOT OCCUPY PREVENT ACCESS**
4. Large cracks in ground, massive ground movement, or slope displacement present which are under, or near, the building and are a hazard to the building.	**DO NOT OCCUPY PREVENT ACCESS**
5. Obvious parapet, chimney or other falling hazard present.	**BARRICADE TO PREVENT ACCESS TO THE AREA**
6. Other hazard present (e.g., toxic spill, chemical spill, asbestos contamination, broken gas line, fallen power line).	**BARRICADE TO PREVENT ACCESS TO THE AREA**
7. Air duct terminals, ductwork, light fixtures lenses or florescent bulbs fallen or dislodged. Suspended ceiling system grid members fallen or dislodged. Broken windows. Overhead mechanical equipment supports or bracing dislodged.	**BARRICADE TO PREVENT ACCESS TO THE AREA**
8. Although no damage is yet apparent, areas with overhead elements similar to those indicated in condition 7 may also fall in an aftershock; therefore, they are are also a possible hazard.	**BARRICADE TO PREVENT ACCESS TO THE AREA**

TABLE 2 REPORTING CODES FOR ENTIRE SCHOOL SITE

Use these codes in reporting to the school district. These codes will be used by OSA/SSS engineers to make a priority listing for inspections by structural engineers. Use one rating code for the entire school site. Use the highest reporting code applicable to the situation of any single building.

Code	Condition
	PRIORITY:
(P1)	1. Sites identified as possible community shelters.
(P2)	2. Sites showing any structural or nonstructural damage to any building which students and teachers have reoccupied the building or intend to do so within 24 hours.
	HIGH:
(H1)	1. Sites showing severe structural damage to any building or ground movement hazards as defined by conditions 1 throuth 4, Table 1.
(H2)	2. Sites showing any structural or nonstructural damage which students and teachers intend to reoccupy between 24 and 48 hours after the earthquake.
	MODERATE:
(M1)	1. Sites showing any structural damage to any building or that have overhead hazards as defined by condtions 5 through 8, Table 1.
(M2)	2. Sites showing any structural or nonstructural damage which students and teachers intend to reoccupy between 48 and 72 hours.
	LOW:
(L)	Sites showing any structural or nonstructural damage which students and teachers intend to reoccupy 72 hours or more after the earthquake.
	ROUTINE:
(R)	Sites showing no damage and very few, if any, books and objects have fallen off shelves.
	NO REPORT:
(NR)	Sites where no report has been made due to lack of communication.

REPORTING PROCEDURE

1. School staff or personnel complete preliminary inspection and, based on inspection results, determine appropriate reporting code using Table 2.

2. Report to school district using reporting codes. If communication is not available to the school district, report directly to the County Superintendent of Schools or the County Office of Emergency Services.

3. School districts receive reports from schools and fill out School District Post-earthquake Damage Reporting form (copy attached). In the event of smaller earthquakes, where communications are available, the school district should directly contact the Office of the State Architect, Structural Safety Section.

4. School districts submit report to the County Superintendent of Schools or, if communication is not possible, directly to the County Office of Emergency Services.

5. The County Superintendent of Schools receives reports from school districts and fills out the County Schools Post-earthquake Damage Reporting Form (attached).

6. The County Superintendent of Schools or County Office of Emergency Services reports to the Office of the State Architect, Structural Safety Section.

7. All County Superintendents of Schools in counties that have had shaking intensity sufficient to knock books off shelves should file a report.

School District Postearthquake Damage

School	Address	Contact Person/ Title	Phone #	Rating									Class Restart Date
				P1	P2	H1	H2	M1	M2	L	R	NR	
School District	Address	Contact	Phone #										District Totals

Priority

(P1) 1. Sites identified as possible community shelters.

(P2) 2. Sites showing any structural or nonstructural damage to any building which students and teachers have re-occupied the building or intend to do so within 24 hours.

High

(H1) 1. Sites showing severe structural damage to any building or ground movement as defined by condition 1 through 4, Table 1.

(H2) 2. Sites showing any structural or nonstructural damage which students and teachers intend to re-occupy between 24 and 48 hours after the earthquake.

Moderate

(M1) 1. Sites showing any structural damage to any building or that have overhead hazards as defined by conditions 5 through 8, Table 1.

(M2) 2. Sites showing any nonstructural or structural damage which students and teachers intend to re-occupy between 48 and 72 hours.

Low

(L) Sites showing structural or nonstructural damage which students and teachers intend to re-occupy 72 hours or more after the earthquake.

Routine

(R) Sites showing no damage and very few, if any, books and objects have fallen off shelves.

No Report

(NR) Sites where no report has been made due to lack of communication.

County Schools Postearthquake Damage

School District	Address	Contact Person/ Title	Phone #	Rating									Class Restart Date
				P1	P2	H1	H2	M1	M2	L	R	NR	
County	Address	Contact	Phone #										County Totals

Priority

(P1) 1. Sites identified as possible community shelters.

(P2) 2. Sites showing any structural or nonstructural damage to any building which students and teachers have re-occupied the building or intend to do so within 24 hours.

High

(H1) 1. Sites showing severe structural damage to any building or ground movement as defined by condition 1 through 4, Table 1.

(H2) 2. Sites showing any structural or nonstructural damage which students and teachers intend to re-occupy between 24 and 48 hours after the earthquake.

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(L) Sites showing structural or nonstructural damage which students and teachers intend to re-occupy 72 hours or more after the earthquake.

Routine

(R) Sites showing no damage and very few, if any, books and objects have fallen off shelves.

No Report

(NR) Sites where no report has been made due to lack of communication.